



Government of South Australia

Department of State Development

Hydrocarbon Prospectivity of the Otway Basin, South Australia

Presentation to IAH Meeting, Adelaide 26 November 2014

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Disclaimer



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Otway Basin overview



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<i>Age</i>	?Jurassic - Late Cretaceous
<i>Onshore Area in South Australia</i>	9650 km ² (3 730 sq. Miles)
<i>Depth to target zones</i>	1000 - 4000+ m
<i>Thickness</i>	> 9 km
<i>Hydrocarbon shows</i>	Onshore commercial gas from Pretty Hill Formation and Windermere Sandstone member, 2000 bbl oil recovered from Sawpit sandstone; offshore oil shows and non-commercial gas
<i>First commercial discovery</i>	1987 gas (Katnook 1)
<i>Production</i>	71.46 PJ sales gas (67.4 BCF) ; 65.84 x 10 ³ kL condensate (Katnook, Ladbroke Grove); 795.2 x 10 ³ t saleable CO ₂ (Caroline)
<i>Basin type</i>	Rift
<i>Depositional setting</i>	Fluvial - lacustrine - marginal marine - deep water marine
<i>Reservoirs</i>	Braided and meandering fluvial, deltaic and slope fan sandstones
<i>Seals</i>	Marine and lacustrine shales
<i>Source rocks</i>	Early restricted lacustrine, later marginal marine to marine?
<i>Depth to oil/gas window</i>	2800 - 4000+ m (oil); 2600 - 4000+ m (gas)
<i>Number of petroleum wells</i>	94 (9 development / appraisal)
<i>Seismic line km</i>	10 492 km 2D, 782 km ² 3D

Key History Milestones

- Exploration commenced in 1866 in the South East with a well drilled at Alfred Flat near Salt Creek (1st oil exploration well in Australia)
- First flow at Kalangadoo-1 in 1965 and Caroline-1 in 1966 – both CO₂
- First commercial flow of hydrocarbons in 1987 at Katnook-1
- Katnook Plant built and commissioned in 1991 – now mothballed
- Oil recovered from Sawpit-1 in 1992, flowed from Wynn-1 in 1994 – neither well commercial



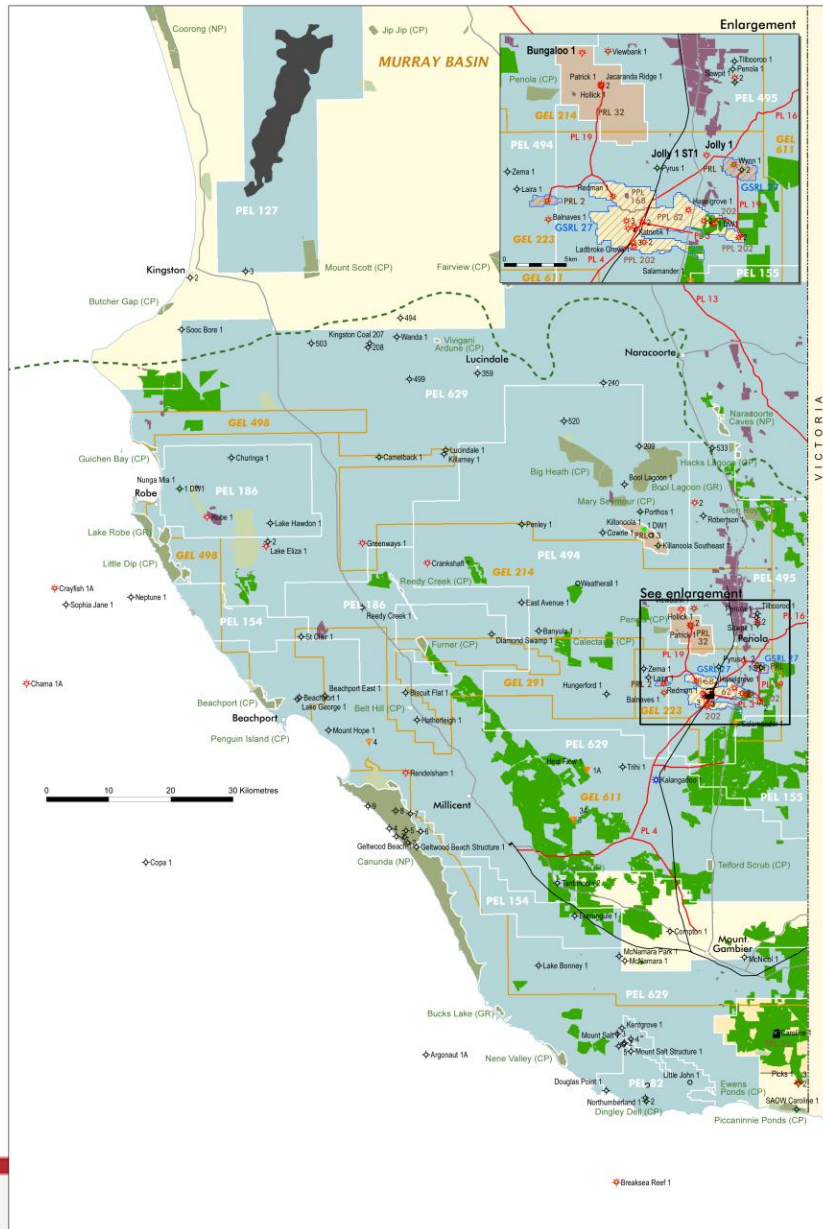
Otway Basin



Richmond Park Bore, Woakwine Dune, near Robe, 1916



Well activity 1910 - 2014



Petroleum wells

- ❄ CO₂ well
- ❄ CO₂ well with oil shows
- ⬮ Dry hole
- ⬮ Dry hole with oil shows
- ⬮ Gas shows
- ⬮ Gas well
- ⬮ Gas well with oil shows
- ⬮ Oil and gas well
- ⬮ Oil and gas shows
- Oil well
- Proposed or currently drilling

Geothermal wells

- ⬮ Abandoned well
- ⬮ Suspended well

Infrastructure

- ⬮ Processing plant
- Town
- Principal road
- Railway

Petroleum tenements

- Gas pipeline
- Petroleum Exploration Licence (PEL)
- Petroleum Production Licence (PPL)
- Petroleum Retention Licence (PRL)

Geothermal tenements

- Geothermal Exploration Licence (GEL)

Gas storage tenements

- Gas Storage Retention Licence (GSRL)

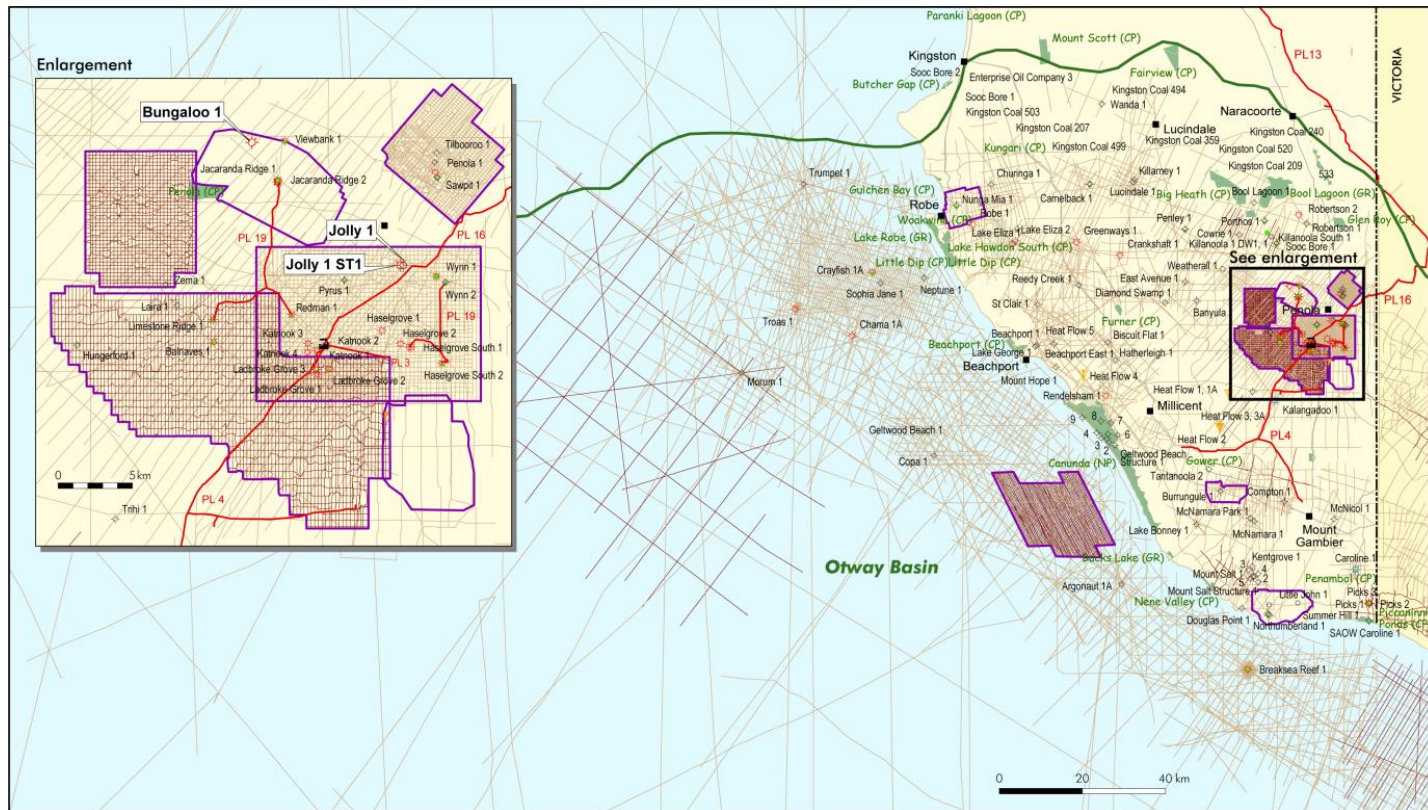
Land use

- Coal deposit
- Vines
- Forest Reserves
- National Parks and Reserves - with petroleum access
- National Parks and Reserves - no petroleum access

YEAR SPUDDED	NO. OF WELLS DRILLED
1910 to 1919	2
1920 to 1929	5
1930 to 1939	1
1960 to 1969	28
1970 to 1979	12
1980 to 1989	20
1990 to 1999	37
2000 to present	12

Conventional oil and gas exploration is
nothing new in the Southeast

Wells and Seismic Lines



Petroleum wells

-  CO₂
-  CO₂ with oil shows
-  Dry hole
-  Dry hole with oil shows
-  Gas shows
-  Gas
-  Gas with oil shows
-  Oil and gas
-  Oil and gas shows
-  Oil
-  Proposed or currently drilling

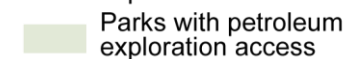
Geothermal wells

-  Abandoned well
-  Suspended well

Seismic lines

-  3D seismic survey area
-  Seismic – post 2000
-  Seismic – 1950–1999

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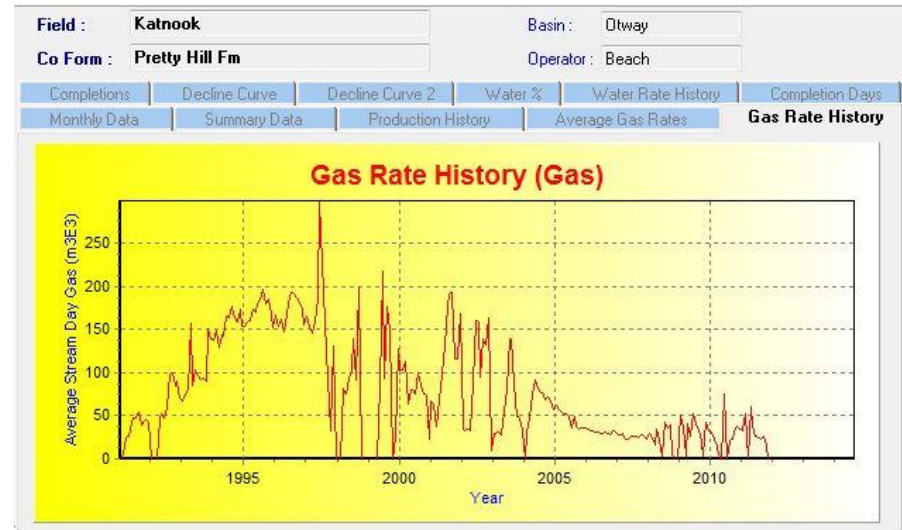
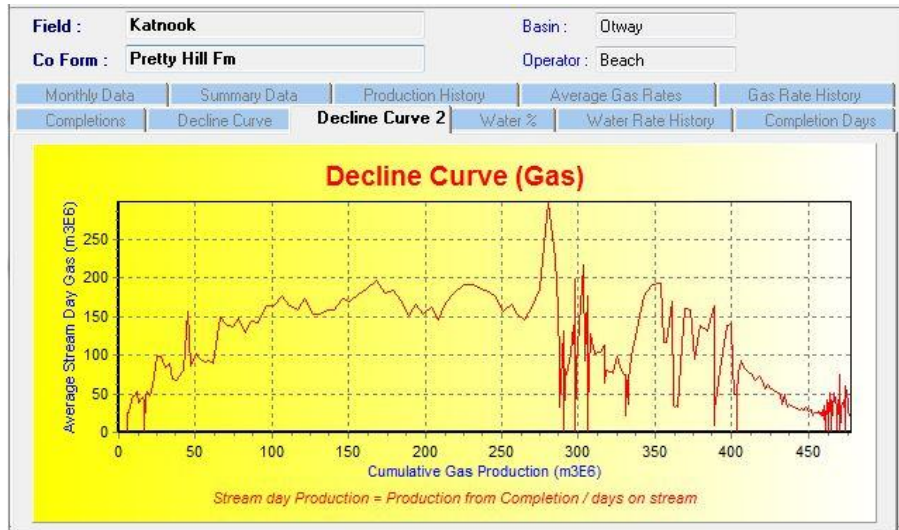


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A	25/2/2002	Issued for Information	R/JF			
Rev	Date	Issue Description	By	Chk	Appr	

Production history

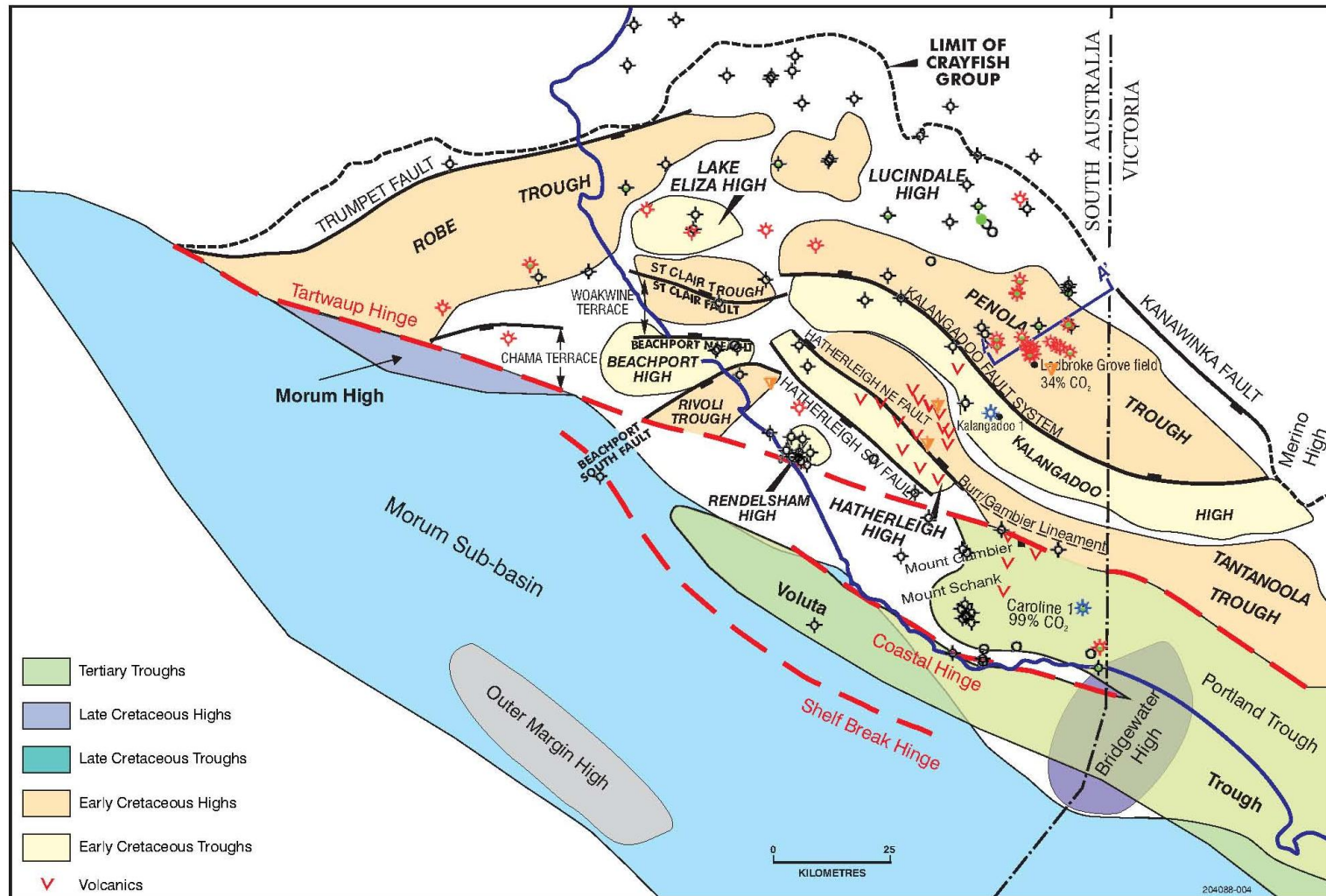


Field	CoForm	DateOnProd	LastProd	GasCum (m ³ E ⁶)
Haselgrove	Pretty Hill Fm	31/07/1994	31/10/2011	307.62
Hollick	Sawpit Shale Member	31/05/2011	31/08/2011	0.02
Jacaranda Ridge	Sawpit Shale Member	31/08/2007	31/10/2011	4.36
Katnook	Eumeralla Fm	31/01/1991	31/05/1992	6.09
Katnook	Pretty Hill Fm	31/01/1991	31/10/2011	477.88
Ladbroke Grove	Pretty Hill Fm	31/12/1999	31/12/2006	1377.47
Limestone Ridge	Pretty Hill Fm	30/04/2010	31/07/2011	10.16
Patrick	Sawpit Shale Member	31/12/2010	31/05/2011	0.17
Redman	Pretty Hill Fm	31/05/1999	30/09/2011	163.33
				2347.10

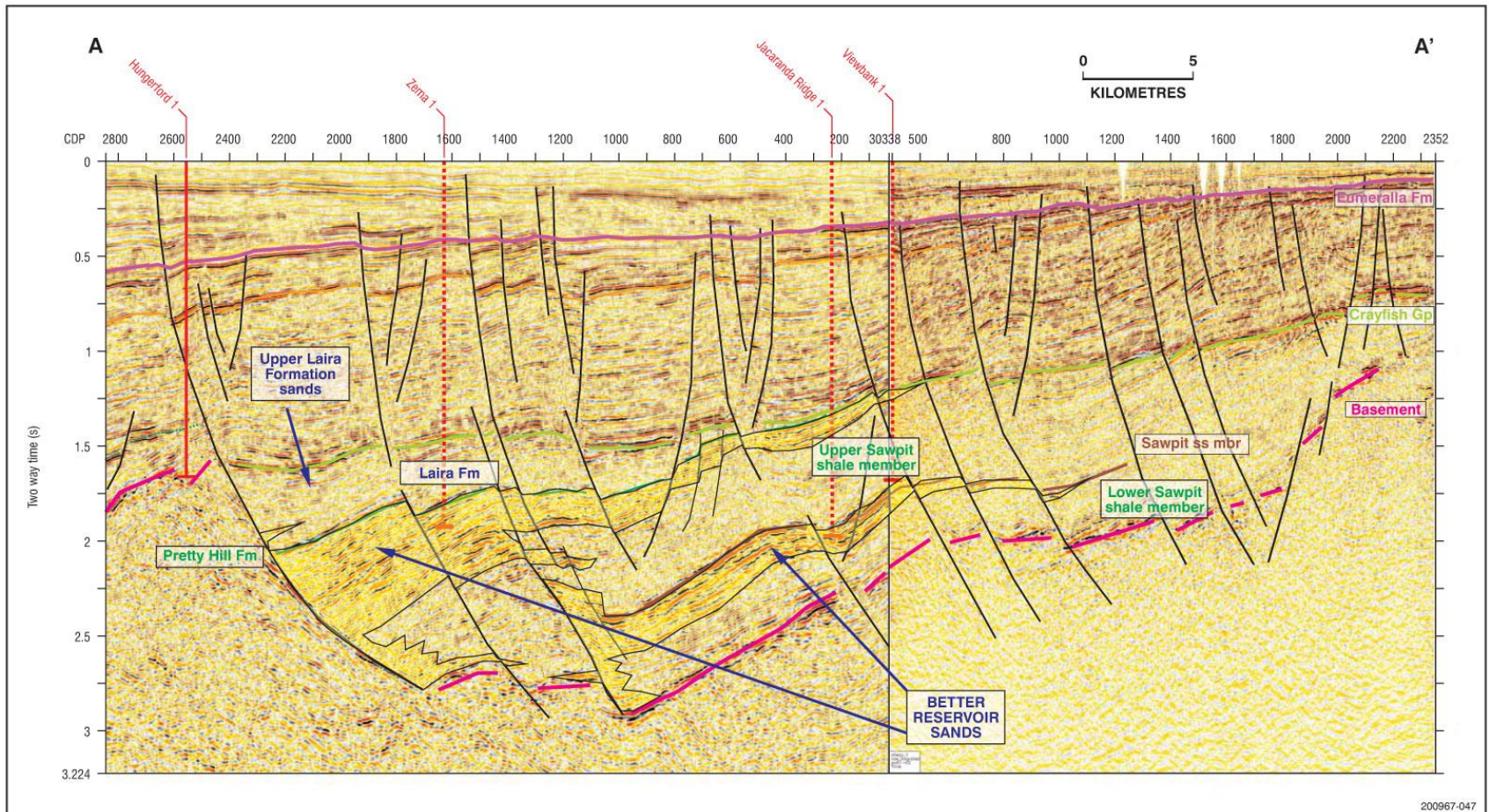
Total sales gas for the last 23 years is ~ 1 year's supply to the Adelaide market

There has been no gas production since end 2011 (other than Caroline CO₂). However, recent drilling results from Beach Energy's drilling and the awarding of PEL 629 to Ouro Preto Resources Pty Ltd in 2013 which includes 7 guaranteed wells by Q3 2019 could breathe new life into the basin.

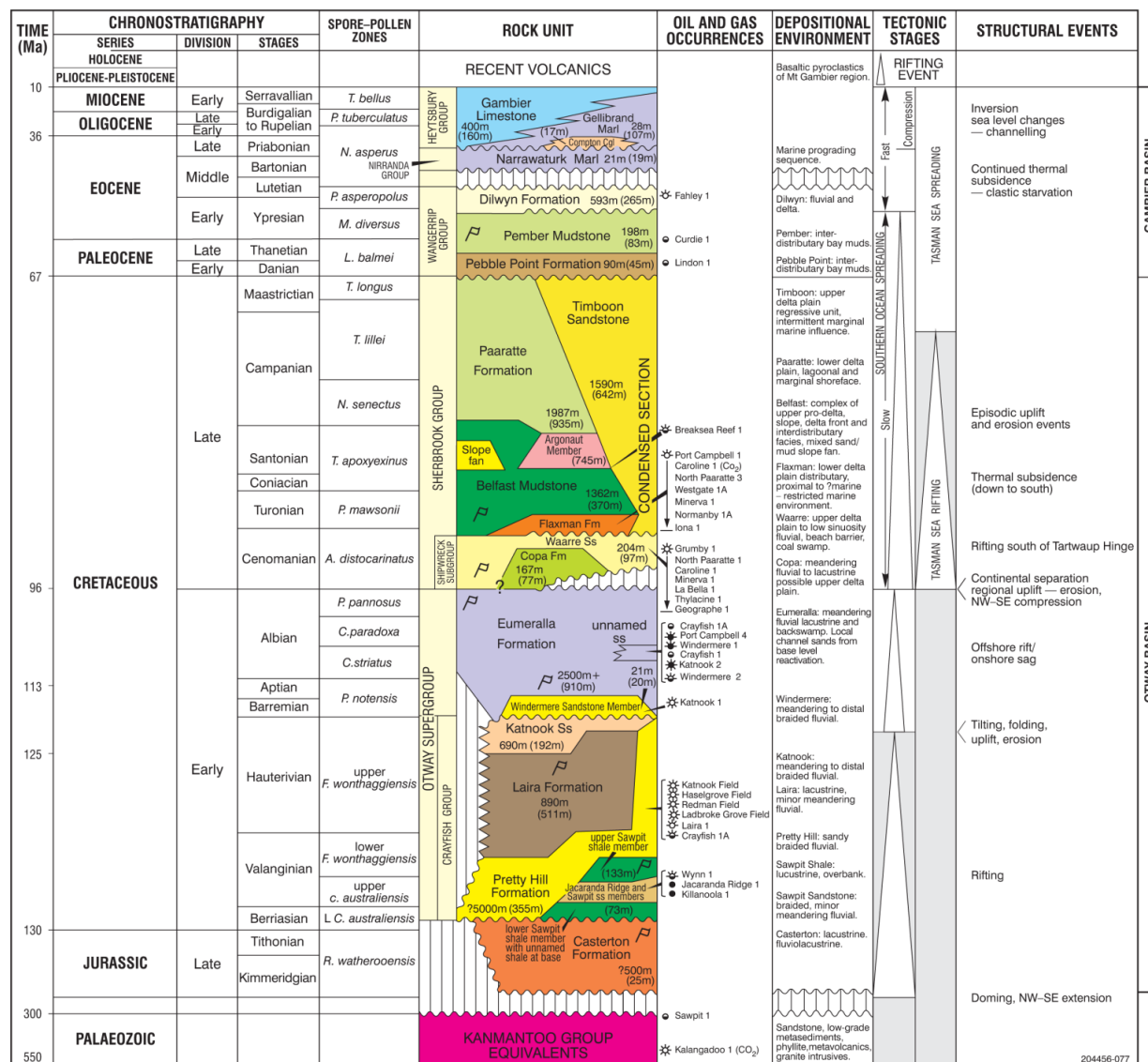
Structural elements



Penola Trough, Otway Basin

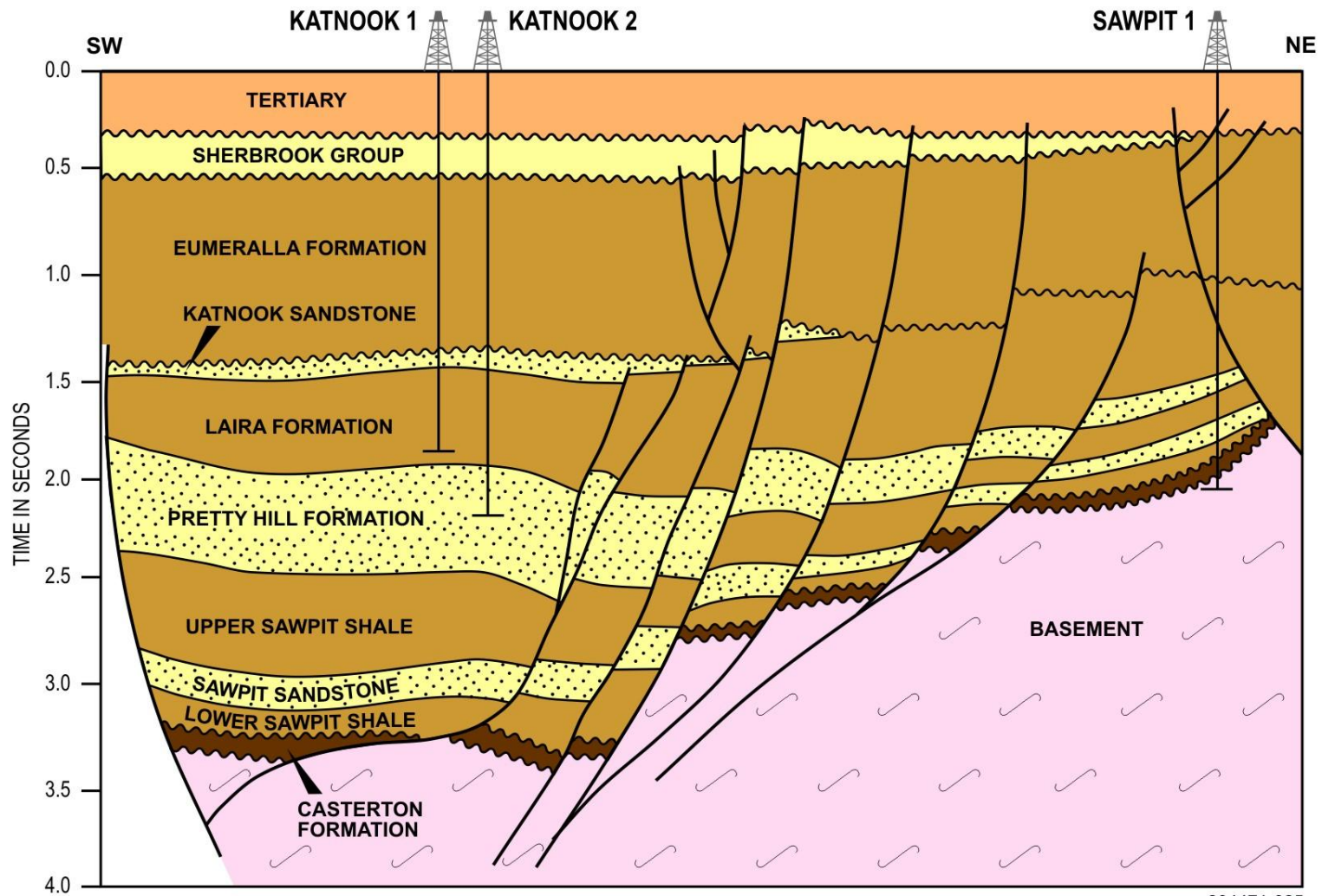


Geological Summary



- Gambier Lst Unconfined Aquifer up to 300m + thick to the south
- Narrawaturk Marl aquitard (<=20m)
- Dilwyn Confined Aquifer (40-740m thick)
- Pember Mdst aquitard (up to 200m in Mt Salt 1)
- Paaratte/Timboon/Flaxman reservoirs – thin in northern part of basin; up to 2000m combined thickness
- Belfast Mdst aquitard – better developed south of Tartwaup Hingezone (up to 362 m in the offshore in Breaksea Reef 1)
- Eumeralla Fm aquitard up to 2500m + with intraformational sands
- Katnook/Windermere Sst
- Laira Fm aquitard up to 890m
- Pretty Hill Fm reservoir (580m+ but may be up to 5000m in deeper parts of Penola Trough)
- Sawpit shales aquitard up to 200m Casterton Fm sand/shale up to 500m+

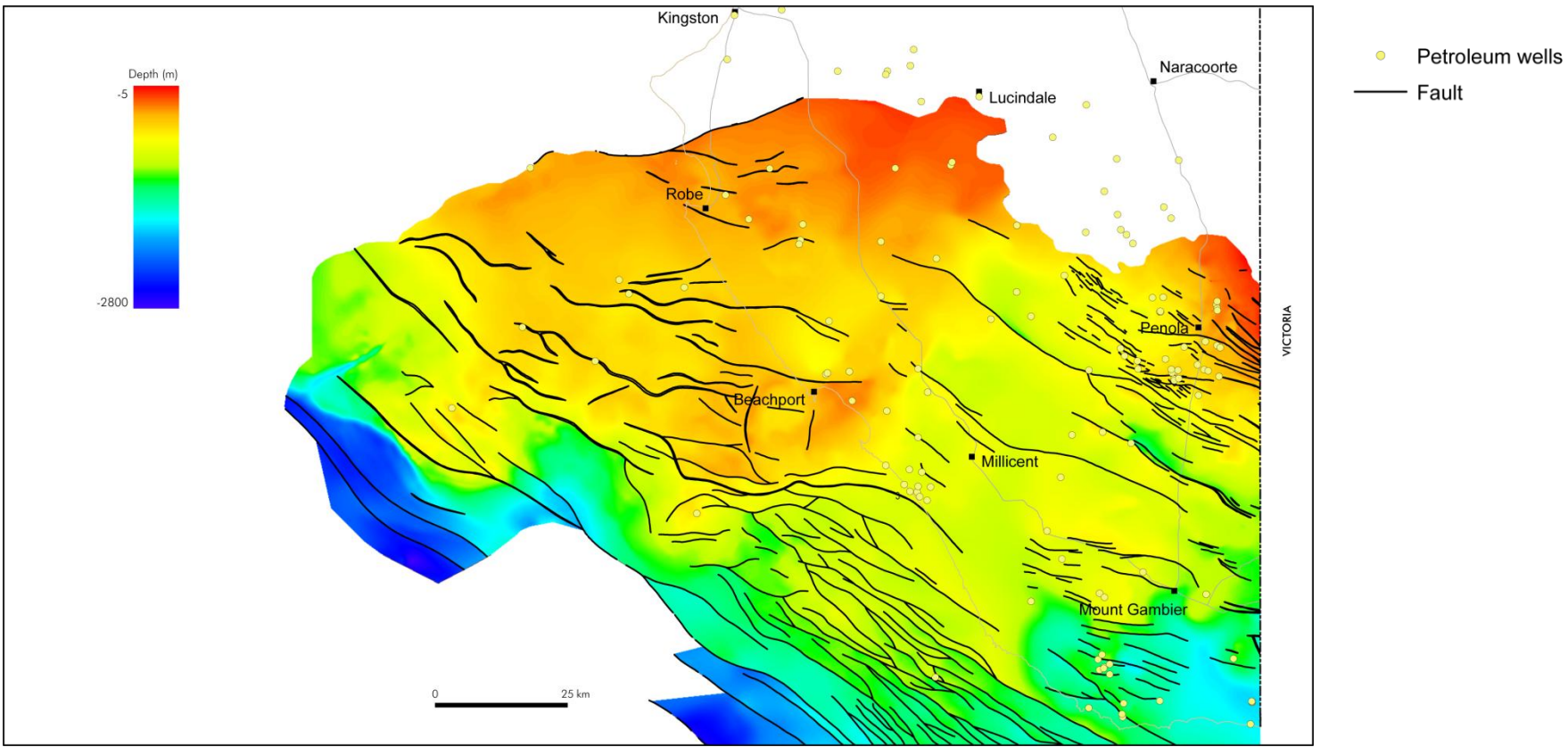
South East Geology



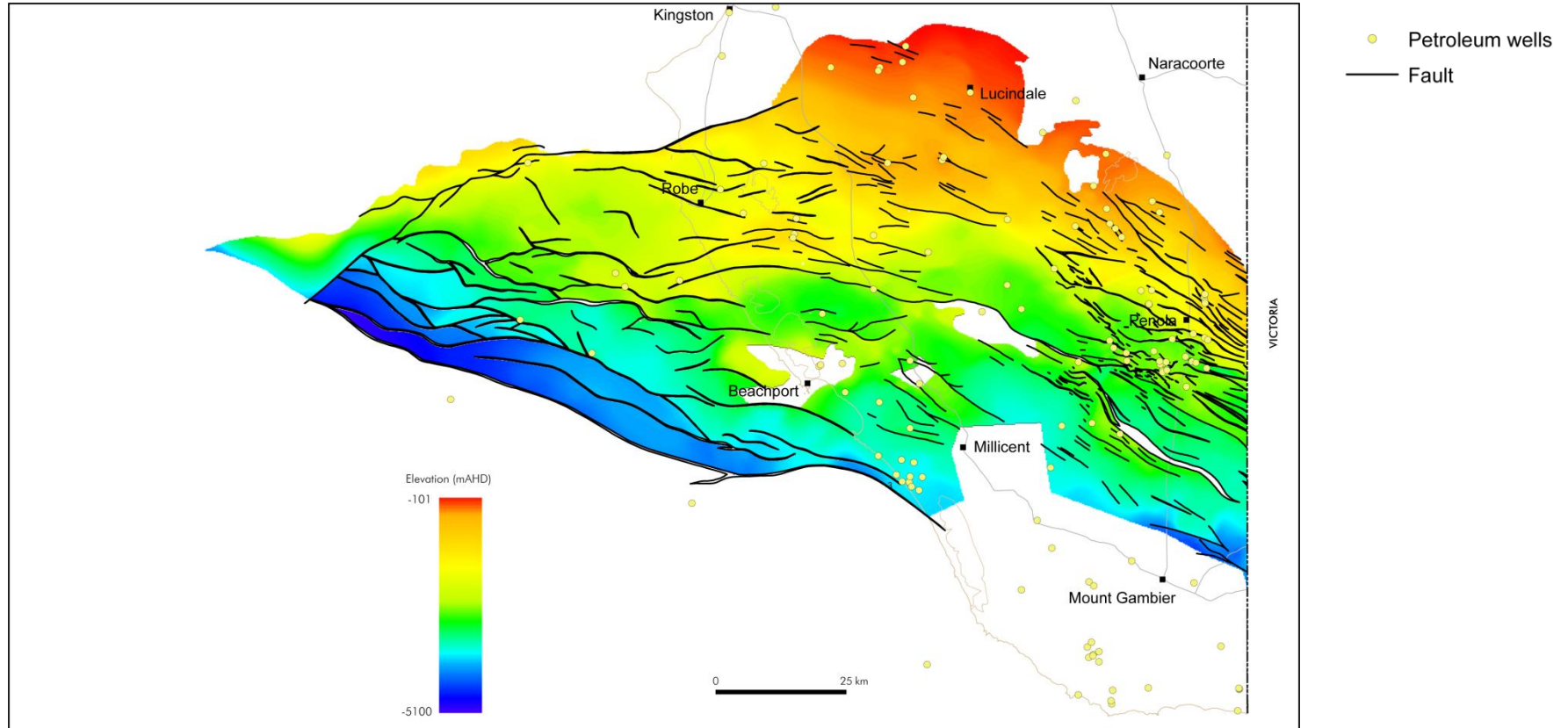
Depth to Top Sherbrook Group



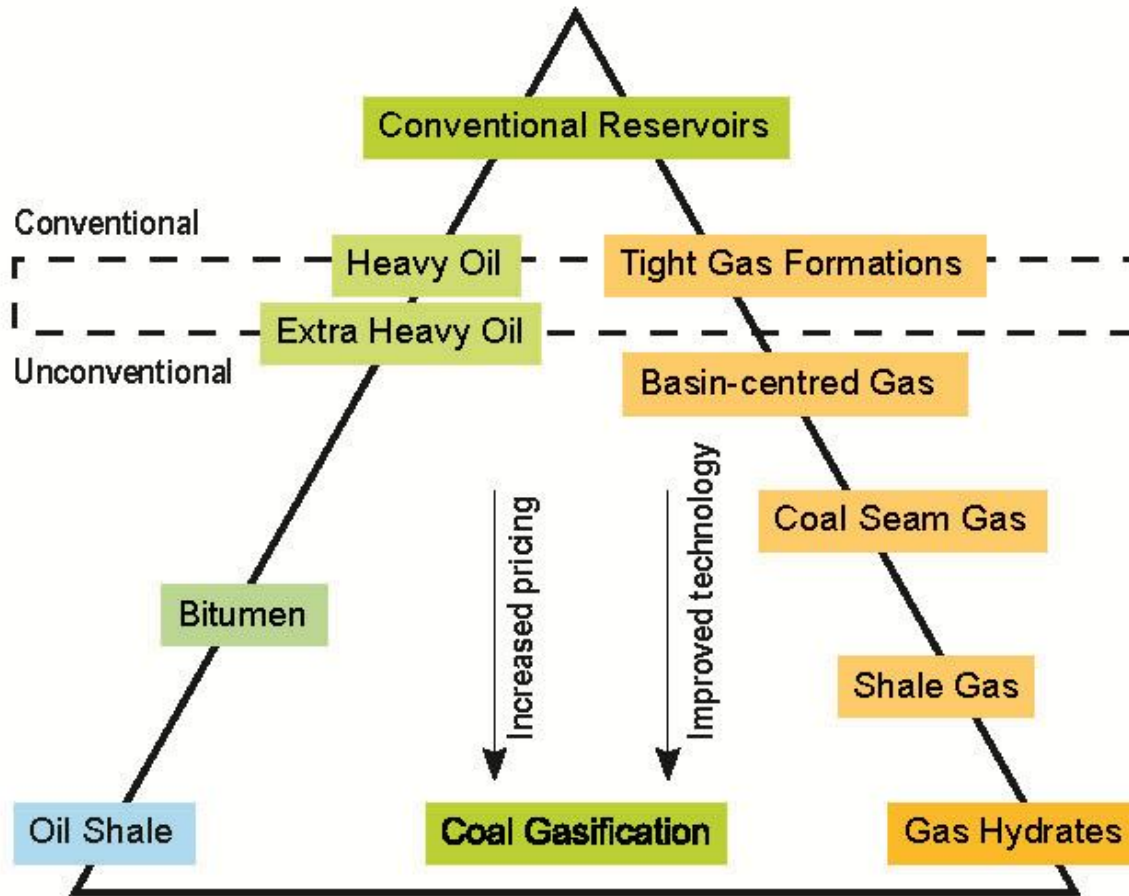
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Depth to Top Crayfish Group

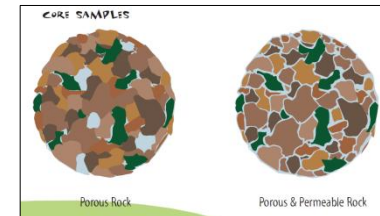


Resource Triangle



Conventional

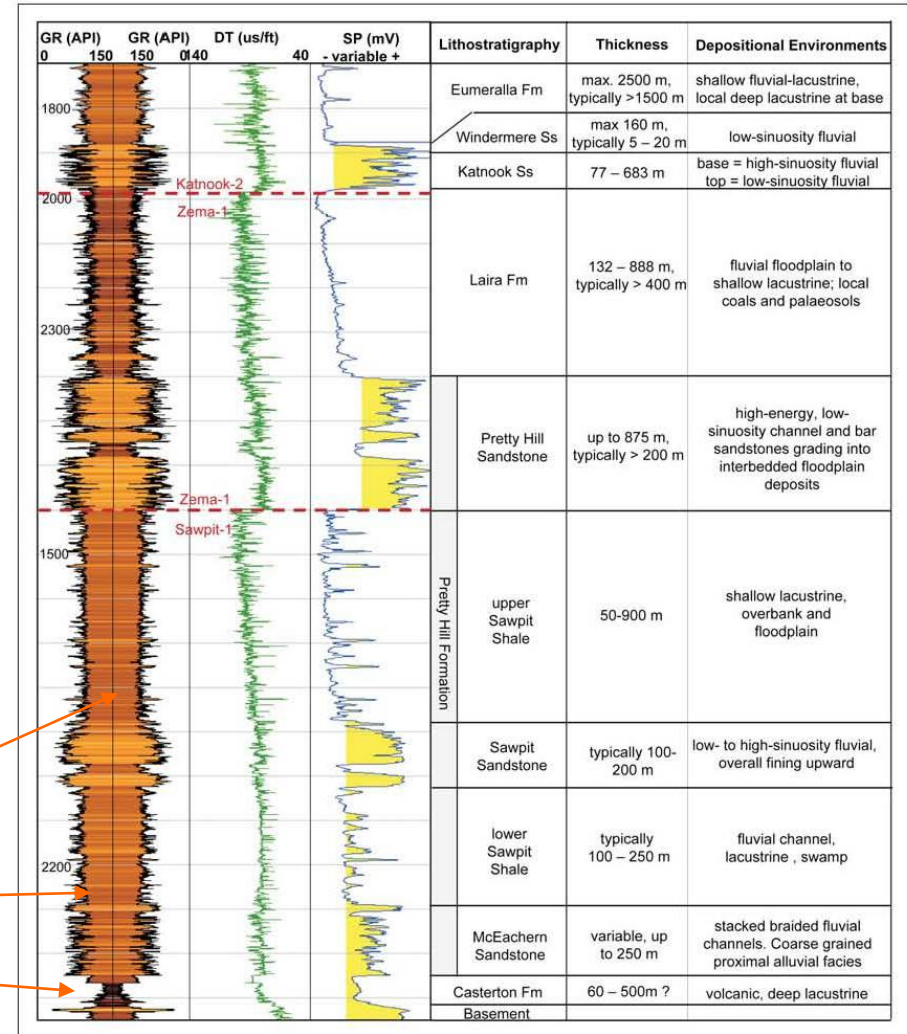
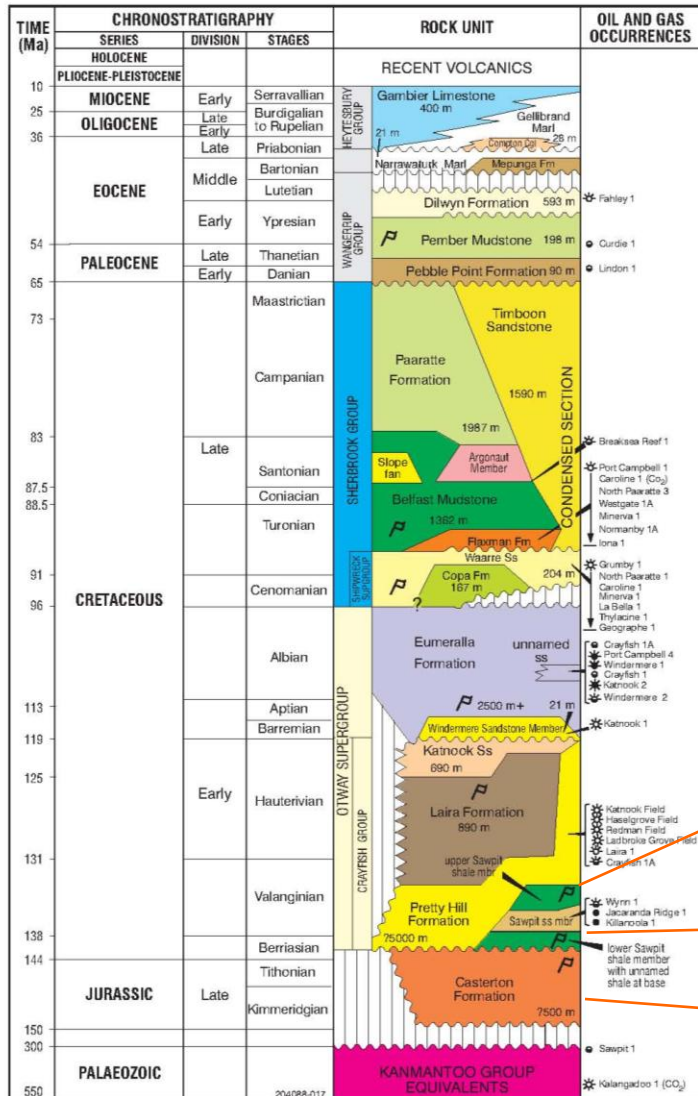
- Porous and permeable rock
- Discrete trap



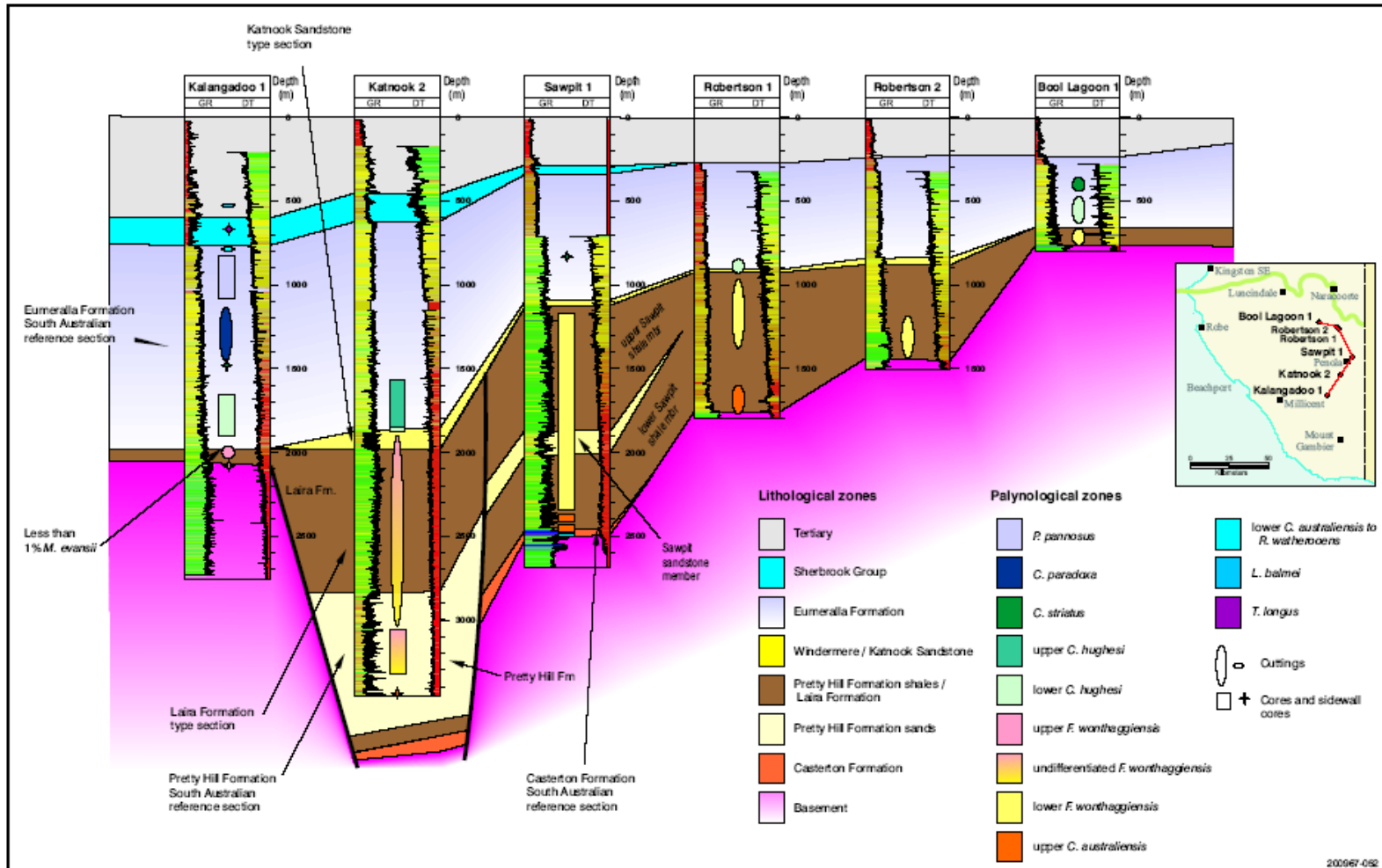
Unconventional

- Large volumes (low recovery factors)
- Require **specialised extraction technologies** = *high extraction cost*
- Higher product prices

Potential shale gas/oil targets



Penola Trough



Robe Trough

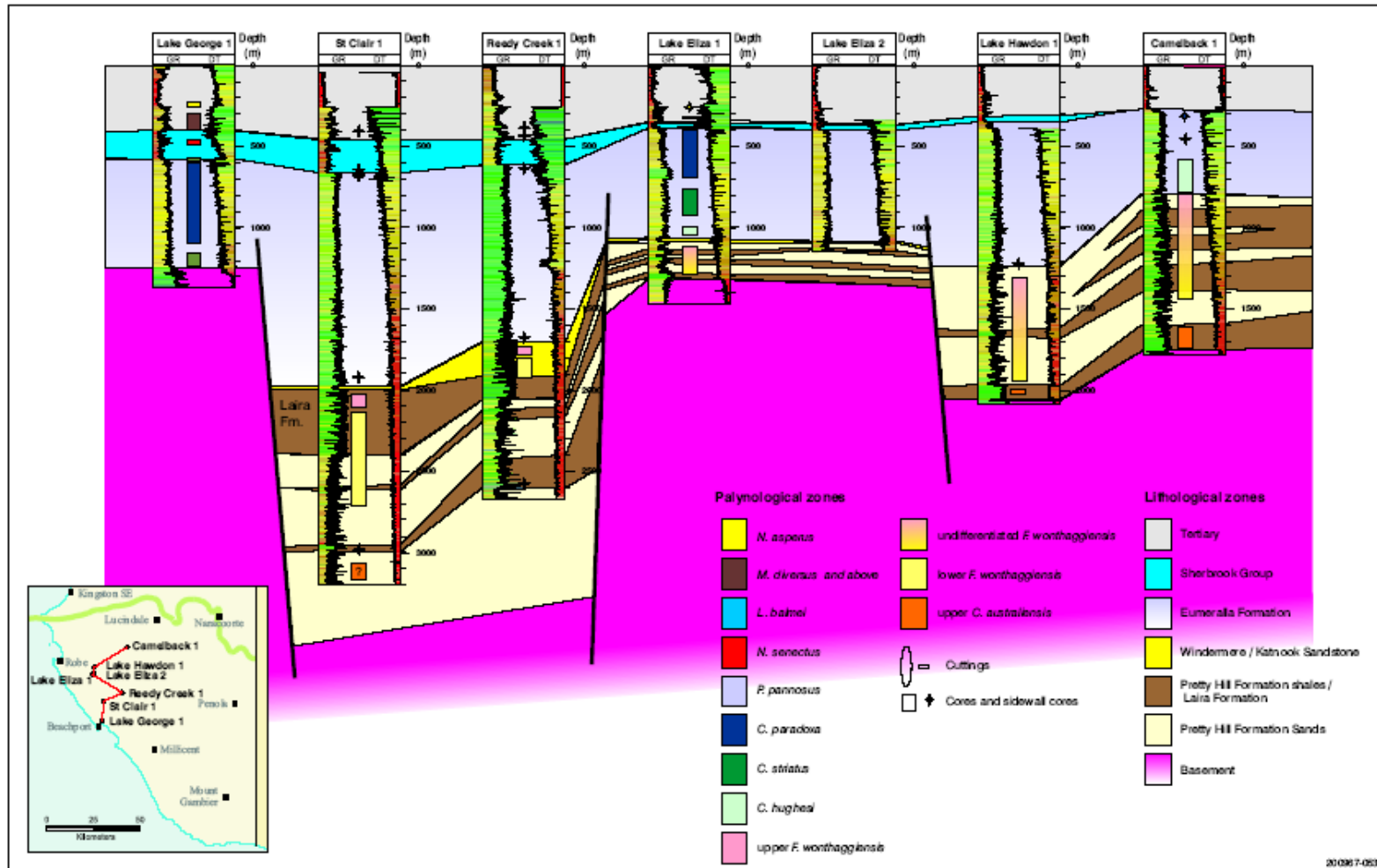
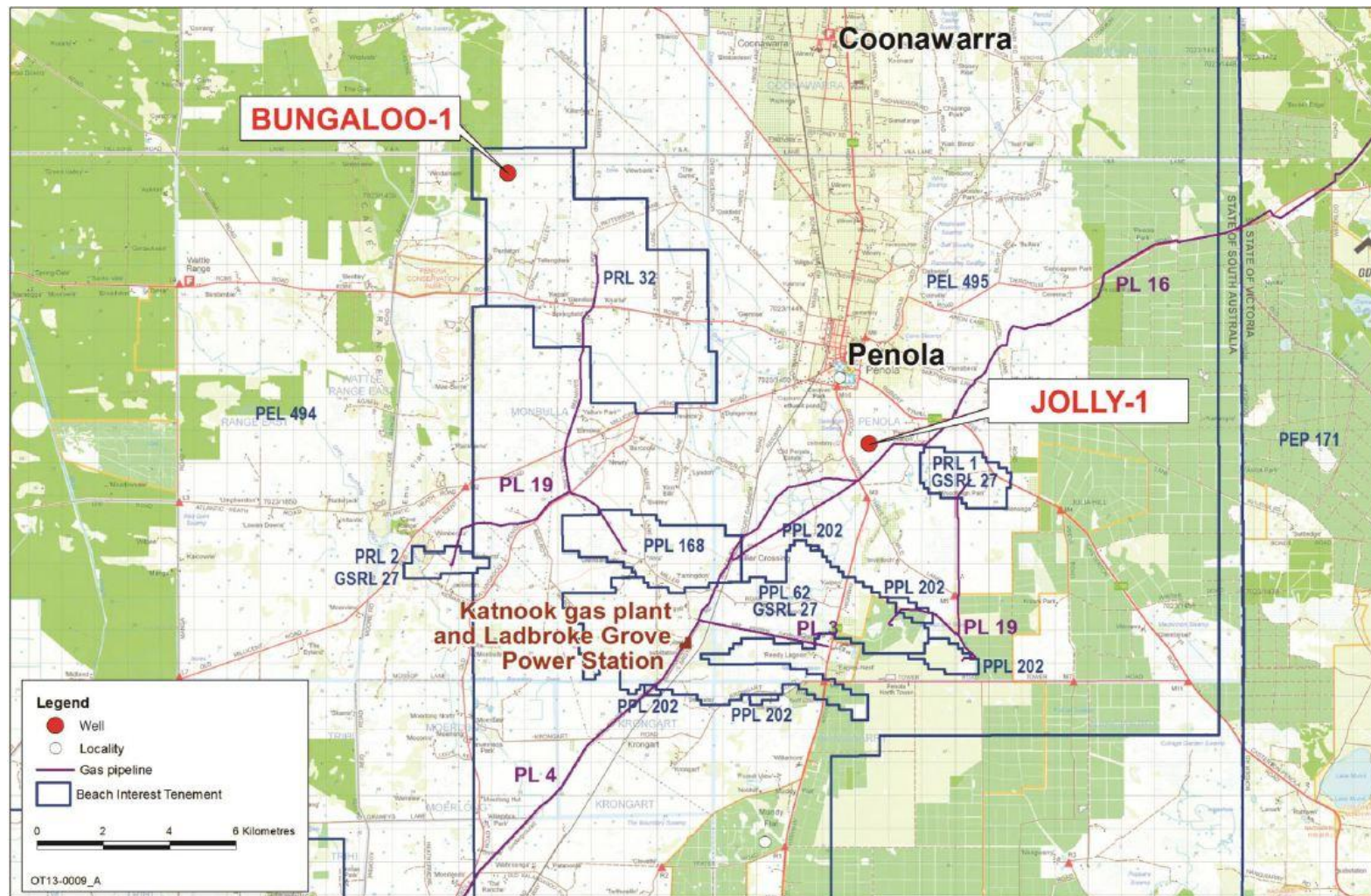


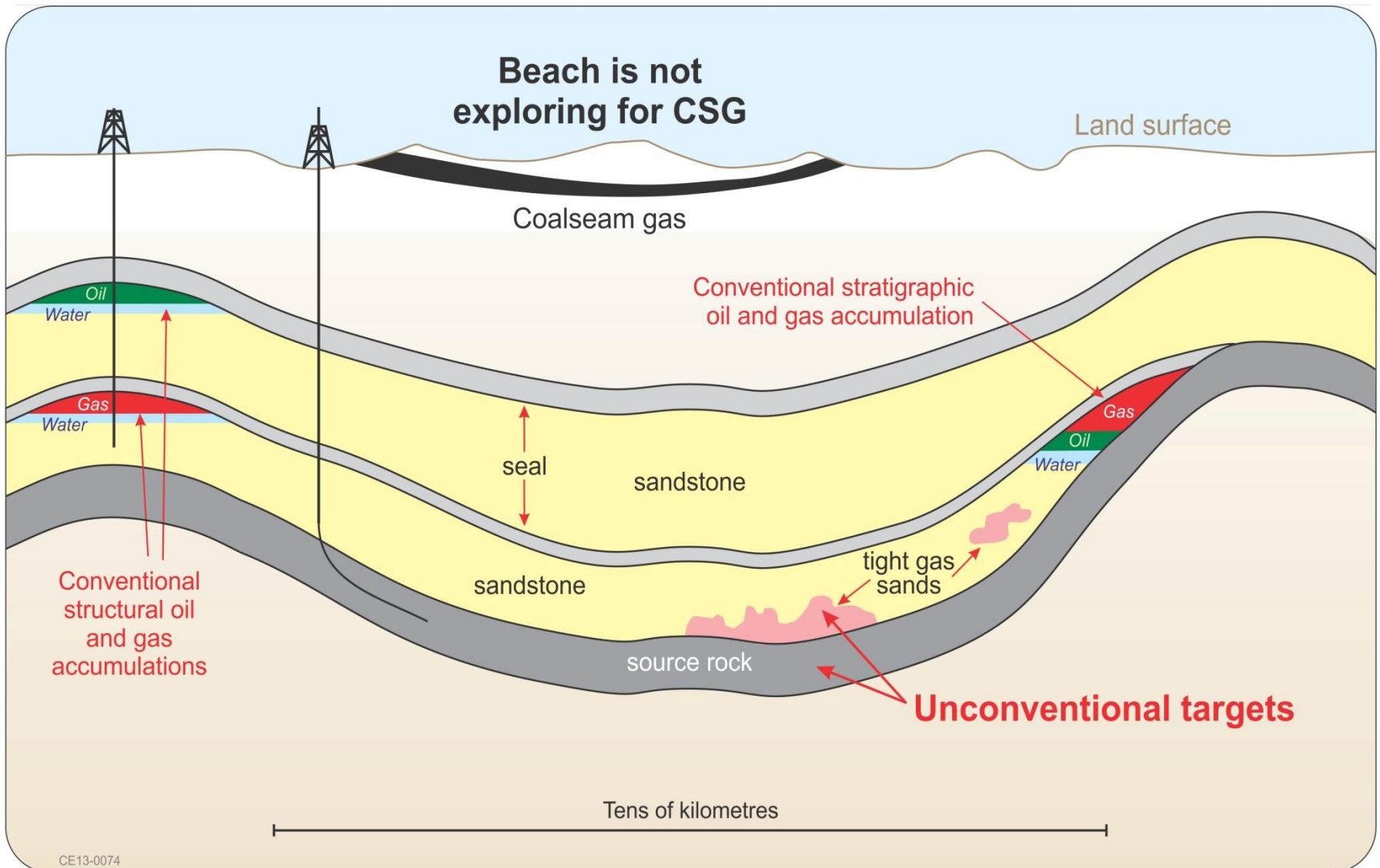
Figure 6.19 Stratigraphic correlation, Lake George 1 to Camelback 1

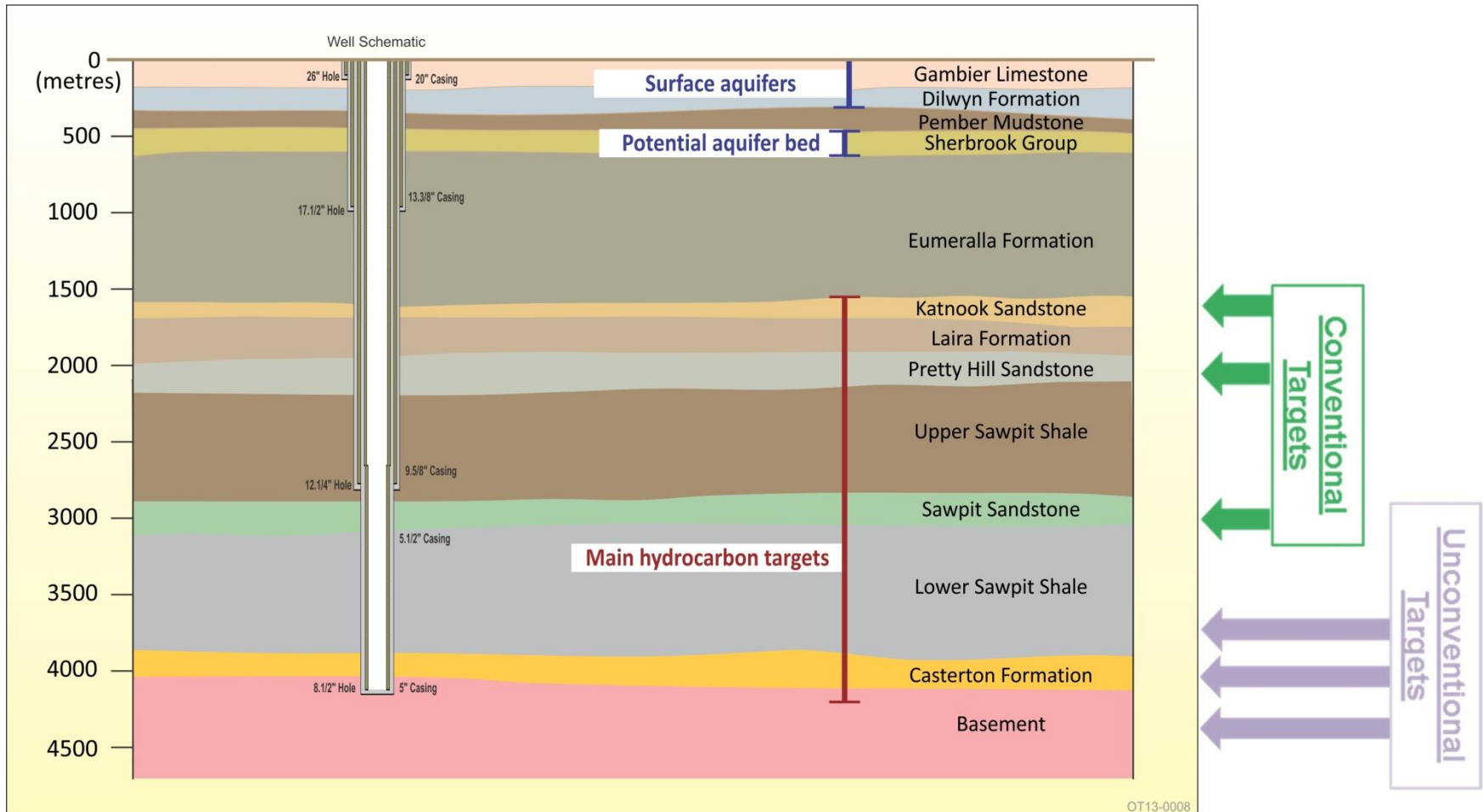
Beach Energy update

- Jolly-1ST1 drilled to 4026 metres and Bungaloo-1 to 3713 metres investigating the deep geology of the Penola Trough
- Drilling showed elevated gas readings over the target formations, the Lower Sawpit Shale and the Casterton Formation
- 181 metres of core cut within these wells and early indications from their analyses are promising
- Sandy interval toward the base of the Lower Sawpit Shale unit has had very good gas shows indicating a potential tight sandstone gas play in the Penola Trough
- Drilling also showed the Sawpit Sandstone is a good conventional target reservoir at depths of at least 3150 metres
- Subsequently conventional Sawpit Sandstone prospects with gas potential have been mapped in deeper areas of the Penola Trough and are being considered for drilling in the near future
- Beach are conducting a study of the deeper untapped aquifers of the Late Cretaceous Sherbrook Group in the Penola Trough region that is nearing completion.



Courtesy of Beach Energy





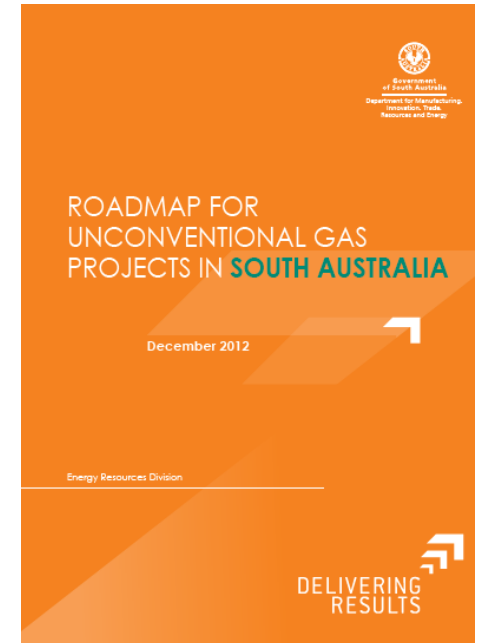
Courtesy of Beach Energy

Roundtable for Oil & Gas Projects

Designed to inform industry strategies, government policies, and regulations to facilitate oil and gas projects in ways that SA communities welcome.

7 working groups formed:

- # 1 Training (Tonsley CoE, Chair Unconventional reservoirs)
- #2 Supply hubs, roads, rail and airstrips for the Cooper-Eromanga basins (Innamincka airport, depots, Strzelecki Track)
- #3 Water use in the Cooper-Eromanga basins (now extended to Otway)
- #4 Minimise red tape for interstate 'wharf to well' corridors to/from the Cooper-Eromanga basins (heavy vehicle, wiring)
- #5 Cost-effective, trustworthy GHG detection
- #6 Suppliers' forum (MIPO)
- # 7 Use gas for transport and heavy equipment

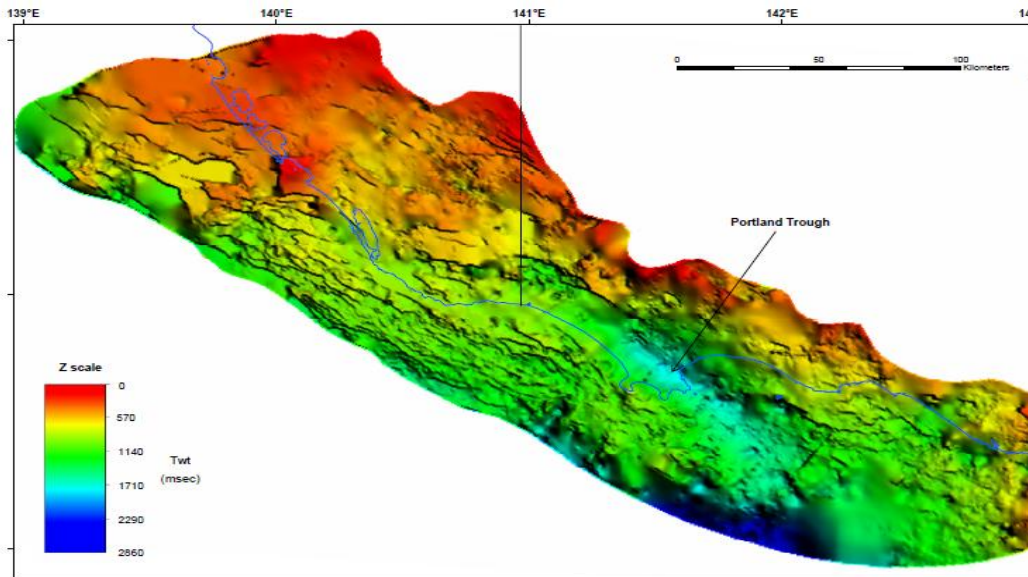
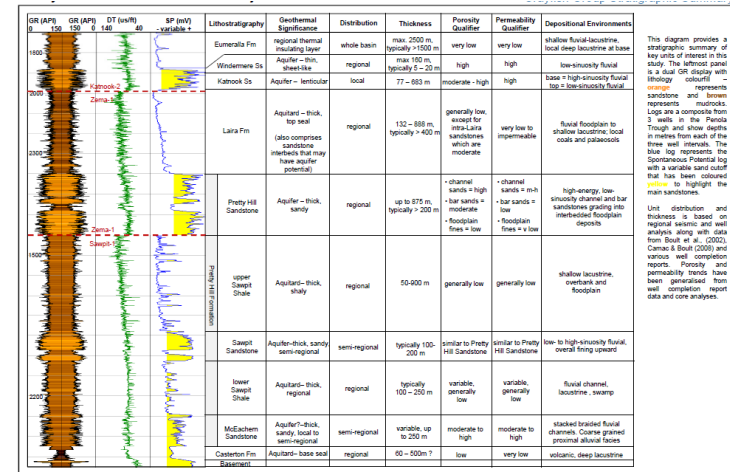
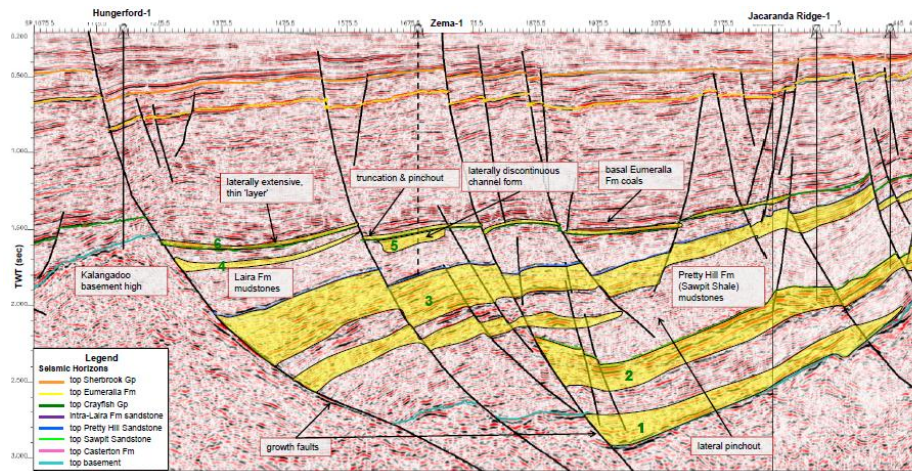


Working Group 3

Update on the status of regional aquifer studies
in the Otway & Gambier Basins, South Australia

Background/Past Studies

- Otway Basin Hot Sedimentary Aquifer & SEEBASE Study 2010
 - FrOGTech Report commissioned by PIRSA, VicDPI and Geoscience Australia DEWNR, SA Water and DSD
 - <https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DD/RB201000010.pdf>
 - Stage 1 provided a regional stratigraphic and structural framework over the entire Otway Basin as a baseline for characterising aquifers from surface to basement in order that government can make informed decisions and respond accordingly to all water affecting activities.
 - Stage 2 provides an opportunity for State water agencies, petroleum and geothermal explorers to develop detailed aquifer characterisation.



Current Projects

- SE Water Quality Monitoring, Evaluation and Reporting Program
 - **Lead Agency: EPA with input from DEWNR, SA Water and DSD**
 - Final Draft Report from Jacobs SKM submitted 21 October
 - Baseline studies gathered and recommendations for future monitoring network to gather water quality data including natural background gas in prospective hydrocarbon exploration areas
 - A key aspect of the proposed MER program is creating links between the SAEPA groundwater quality monitoring, the Department of Environment, Water and Natural Resources (DEWNR) groundwater status reporting and groundwater MER works undertaken by the SE NRM Board (the Board).

Current Projects

- Framework for a Regional Water Balance Model for the SA Limestone Coast Region
 - **Lead Agency: Goyder Institute or Water Research, NCGRT, DEWNR, CSIRO, Flinders Uni, U of A, UniSA (Harrington & Lamontagne (Eds)**
 - Phase 1 completed and forms part of a longer term research program which will also address 3 tasks:
 - 1. Develop a regional water balance framework
 - 2. Assess the spatial variability and indicative fluxes of groundwater discharge to the marine environment
 - 3. Assess the role of geologic faults on regional groundwater flow and inter aquifer leakage
 - http://www.goyderinstitute.org/uploads/South_East_Water_Balance_Final%20for%20web_high.pdf

Proposed Projects

- DSD has engaged the NCGRT to review and synthesise information on water impacts of unconventional gas developments, and to describe methods that can be used to assess risks of current and future developments.
- Project title: **The Impact of Unconventional Gas on Water Resources: Replacing Myths with Scientific Evidence.**
- The project will:
 - Draw together information from scientific studies and reports worldwide;
 - Describe how each risk factor can increase risk, and use scientific data and models to quantify the risks; and
 - Present examples where risks have been realised
- Project to commence in Jan 2015 to be completed by Dec 2015
- **Lead Investigator: Professor Craig Simmons**

Projects underway

- The Geological Survey of Victoria has recently completed a tender process for the provision of a 3D geological framework model of the onshore Otway Basin. This will involve interpretation of seismic, well and potential field data. This work will support Victoria's water science studies in order to provide a response to government on the potential impact on onshore gas on the State's water resources. Estimated delivery ~June 2015.

Opportunities

- DSD is keen to engage with Geological Survey of Victoria and relevant state and federal agencies and industry to cost share the consolidation of baseline studies that will provide regional potentiometric surfaces (using latest knowledge of fault polygons) and salinity maps for at least the Tertiary Unconfined and Confined Aquifers.
- A longer term aspiration is to facilitate the full characterisation of all aquifers from surface to basement so that government can fully respond to the potential impact of any activities on the State's water resources and realise potential new water supplies.

Questions



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